

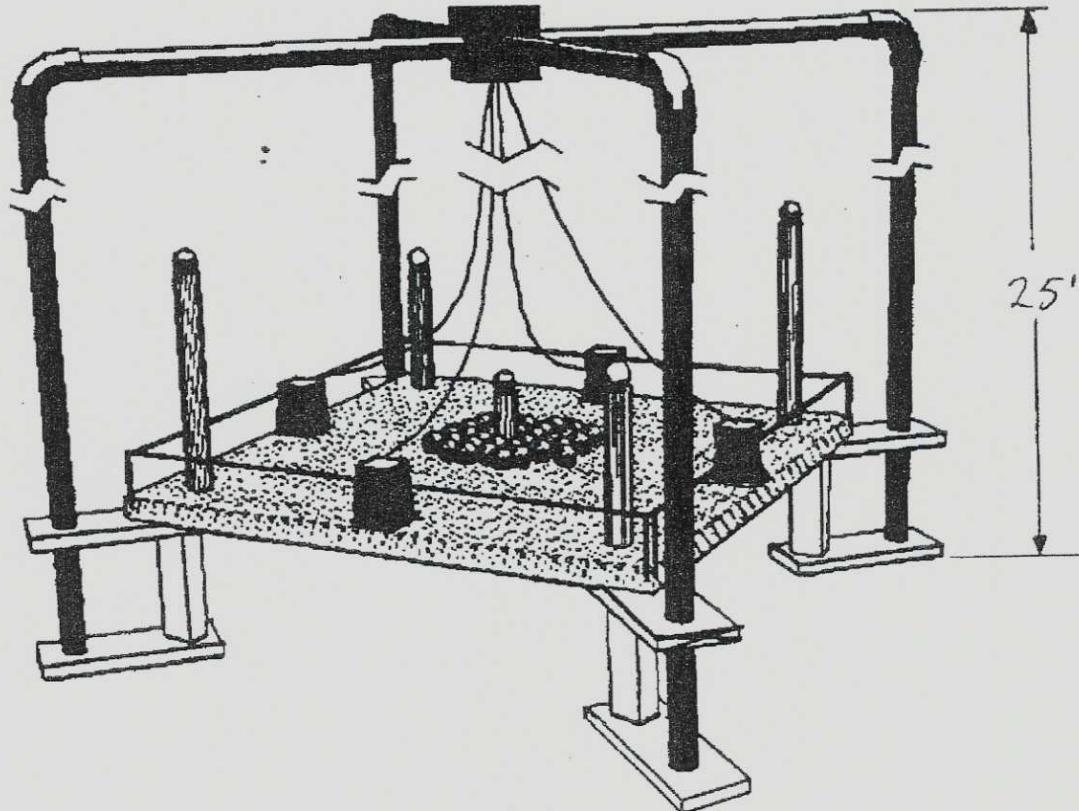
**U.S. FIRST PRESENTS  
"MAIZE CRAZE"**

**A NATIONAL TECHNOLOGY CHAMPIONSHIP IN  
CREATIVE DESIGN AND SCHOOL PARTNERING**

**JANUARY 3 - FEBRUARY 14, 1992**

FIRST Encounters is a design competition in which high school students are paired with professional engineers to design and build a remotely operated mechanical device which will compete against other machines of its type to win top honors.

The object of the "Maze Craze" is to gather as much "treasure" as possible into the team's own home base. In each match four teams compete for 3 high-value tennis balls and 2 medium-value balls located on 5 posts around the field, and for 150 low-value balls lying on the field around the central post. Each match lasts 2 minutes. The winner is the team that has the highest total point value of tennis balls within its home base at the ending bell. In case of a tie, the device that reached its home base first wins.



**Not To Scale**

## OBJECT

To design and build a remotely-controlled device to collect "treasure" from the playing field and posts, and to defend it against other opponents. The playing field and posts are illustrated in the attached diagram.

## CONSTRAINTS

### Materials

With the following exceptions, each machine must be constructed solely from materials provided in the "Kit":

- up to \$200 worth of materials purchased from the Small Parts Catalog;
- fasteners, washers, and adhesives may be used for fastening and joining only;
- adhesive tape may also be used as an electrical insulator;
- lubricants used only to reduce friction within your own device;
- nonfunctional decorations;
- a common, 9-volt, "transistor radio" battery;
- the Rubbermaid container and packing materials are not part of the kit.

### Energy Sources

The energy used by the devices in the competition must come solely from:

- a change in the altitude of the center of gravity of the device;
- storage achieved by deformation of the tension, compression and constant force springs provided in the Kit;
- electrical energy derived through the umbilicals during the duration of each contest.
- electrical energy derived from the common 9-volt "transistor radio" battery that participants may add to the kit materials.

### Size

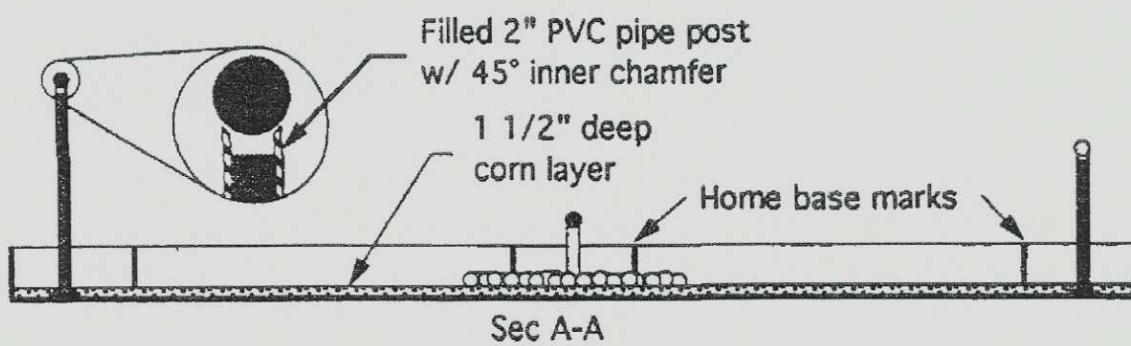
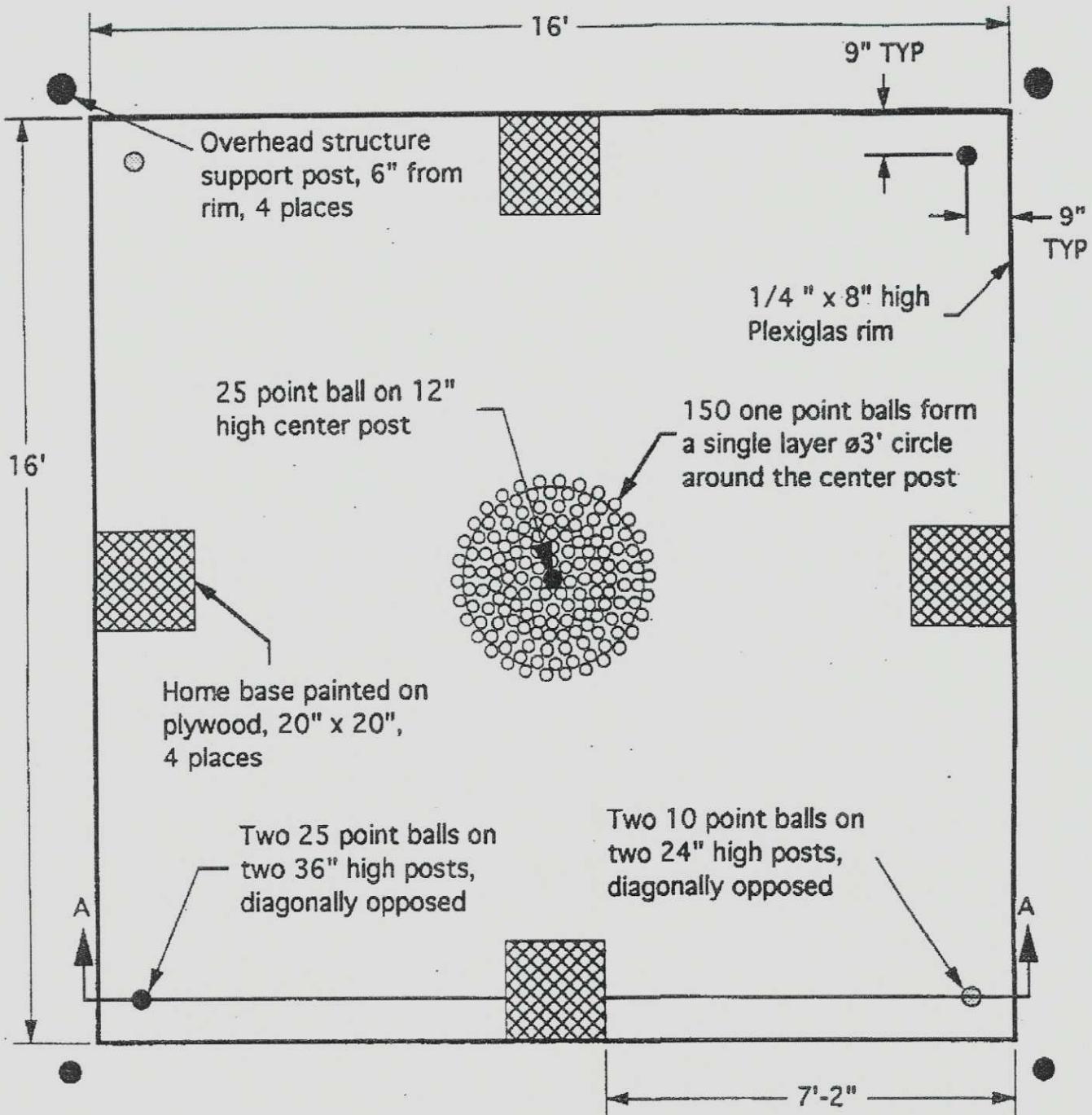
At the start of each match the machine must fit, unconstrained, within a 38 cm by 50 cm by 34 cm (WxLxH) rectangular container. These are the dimensions of the largest rectangular solid that will fit within the Rubbermaid shipping container.

### Weight

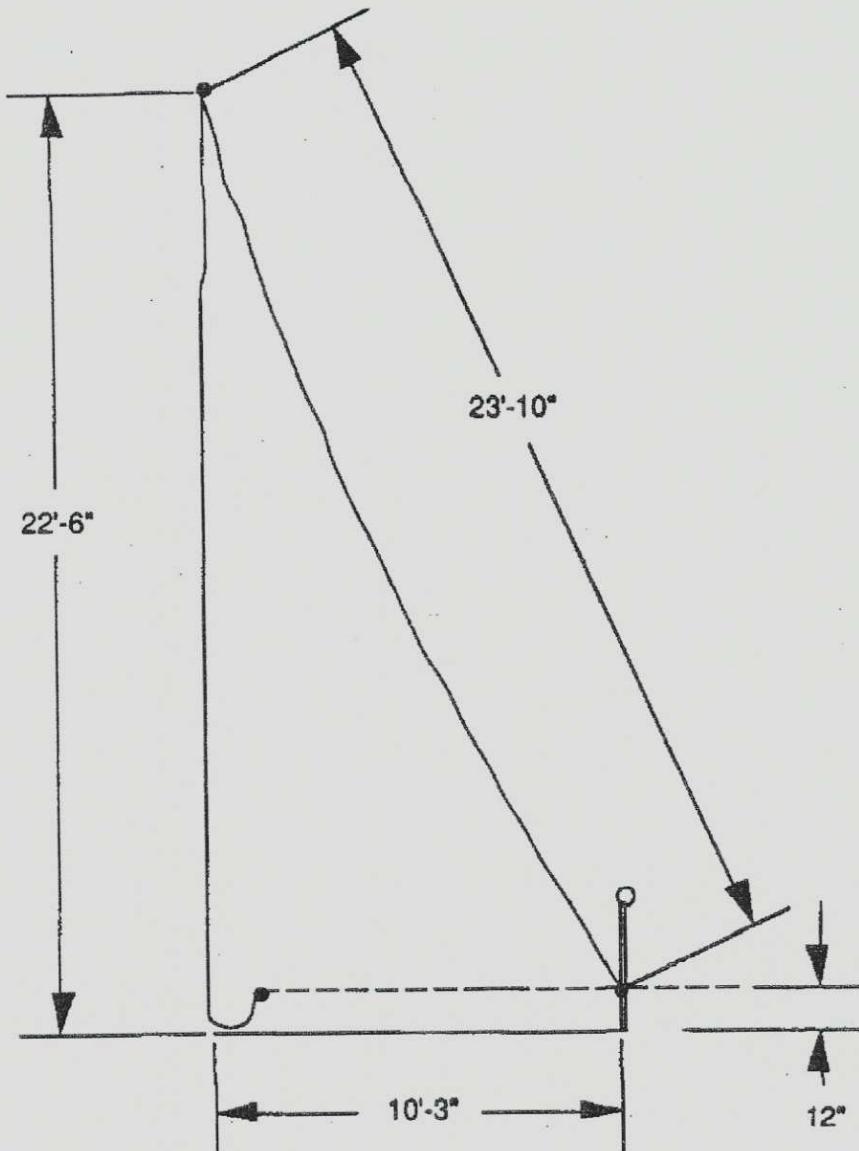
The "weight" of the machine must not exceed 11 kg (24.2lb).

## EVALUATION

The winner of each contest will be the team with the highest point value of tennis balls within the confines of its home base at the end of the 2 minute match. The overall winner will be chosen in a double elimination tournament.



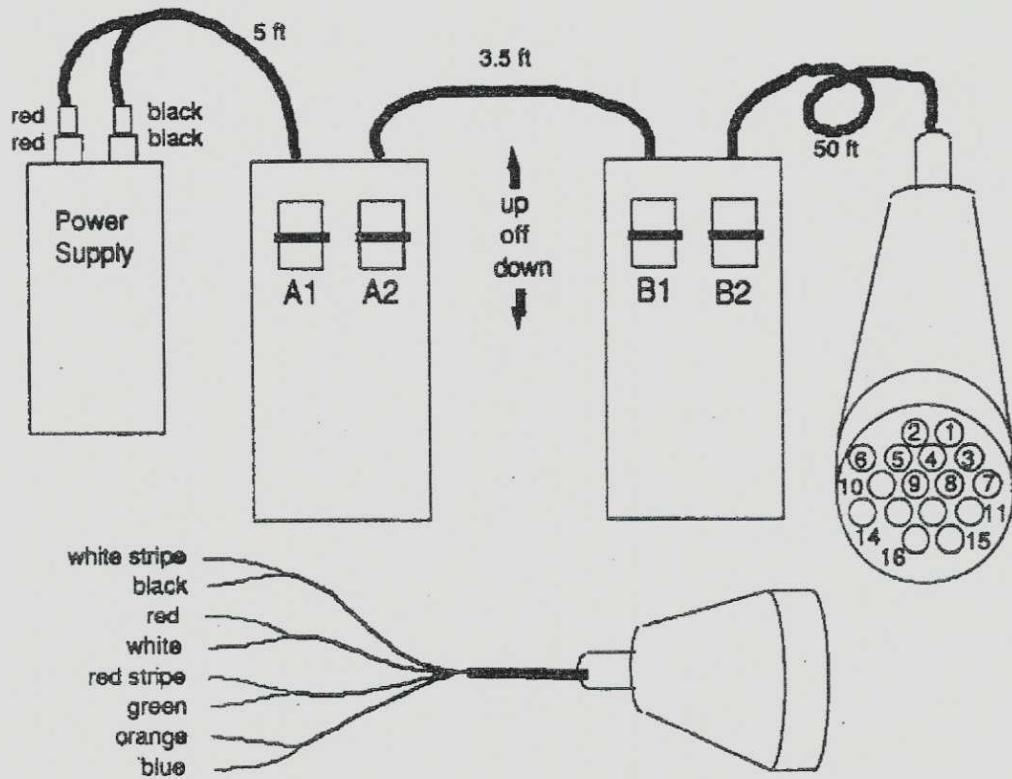
## CONTROLLERS & UMBILICALS



Each table will be equipped with four identical umbilicals provided by the organizers. The umbilicals will be suspended from a common point 22'-6" directly above the center of the playing field. Each umbilical will be 23'-10" long from the point of suspension to the end of the connector allowing, the umbilical to be 12 inches above the field when extended all the way to a corner post. When the umbilical is hanging loose there is only 1'-4" of slack, which can be compensated for with the height of the machine so that it does not drag on the field. The problem of a tangled or too-short umbilical is not a trivial one, and on many occasions it has made devices useless by getting entangled in critical components of the device. The attachment of the umbilical should be accounted for in the design process.

Kits contains a set of controllers with 50 ft of umbilical cable, to allow each team to simulate the actual set up which will be present at the competition. The two control boxes are mounted in series between the power supply and the umbilical. Each one has two Double Pole, Double Throw spring loaded switches, which allow you separate control of up to 4 motors. NO MODIFICATION OF CONTROL BOXES OR THE POWER SUPPLY IS ALLOWED. The controllers are for practice purpose only. Below is a table and a drawing showing the controller set-up, position of individual switches and the polarity of corresponding wires and pin .

Switch #, Position	Positive Wire/Pin #	Negative (common) Wire/Pin #
A1, Up	White stripe/2	Black/1
A1, Down	Black/1	White stripe/2
A2, Up	Red/14	White/6
A2, Down	White/6	Red/14
B1, Up	Red stripe/15	Green/16
B1, Down	Green/16	Red stripe/15
B2, Up	Orange/3	Blue/7
B2, Down	Blue/7	Orange/3



## POWER SPECS FOR MOTORS

The Portescap motors have been tested to have a no load RPM of 8000 at 13.5 V.

The performance of the Delco motors is approximately as shown:

TORQUE (N.M)	SPEED (RPM)		CURRENT (A)		POWER (W)		EFFICIENCY (%)	
	12 VOLT	13 VOLT	12 VOLT	13 VOLT	12 VOLT	13 VOLT	12 VOLT	13 VOLT
0	4916	5340	0.72	0.74	0	0	0	0
0.02	4495	4903	1.64	1.65	9.24	10.07	47	47
0.05	3937	4303	2.94	3	20.22	22.1	57	57
0.07	3576	3877	3.85	3.98	25.71	27.87	56	54
0.1	3010	3230	5.2	5.43	30.91	33.17	50	47

## ORDERING PROCEDURE FOR SMALL PARTS CATALOG

1. To order any part from the Small Parts Catalog, first call the order department at 305-557-8222 and check for availability and price.
2. Send the part, part number, page number and quoted price to:

Deka  
Attn: Mike Ambrogi/Kendell Moore  
340 Commercial St.  
Manchester, NH 03101  
phone: 603/669-5139  
fax: 603/624-0573

Try to have your order faxed by two o'clock in order to meet the deadline for second day shipments. There is a minimum charge of fifteen dollars per order. It would be appreciated if your order could be placed all at once. Only two orders will be accepted per team in order to minimize shipping costs.

## TECHNICAL AND JUDICIAL HOTLINE

If at any point in the design process you run into technical difficulties or need clarification of any of the rules, you may reach:

Andrzej (Anjay) Skoskiewicz @ 617/253-3226  
or email @ acs@athena.mit.edu (except Jan 14-21)  
or Mike Ambrogi at 603-669-5139  
to answer any of your questions.

## KIT COMPONENTS

### Consumable

Aluminum sheet, 1/16" x 12" x 18"	1	String, thin, 12'	1
Aluminum sheet, 1/8" x 4" x 4"	1	String, medium, 6'	2
Aluminum bar, 1/2" x 12"	2	Twine, 6'	1
Aluminum foil (T-shirt wrap)	1	Cable, 8 conductor, 5'	1
Drill rod, ø1/4" x 18"	1	Hardware mesh, 1/4", 12" x 18"	1
Drill rod, ø3/16" x 18"	3	gearbox housing w/ 4 bolts	1
Brazing rod, ø1/16" x 18"	6	Velcro Strip, male/female, 1" x 24"	1
Brazing rod, ø1/8" x 18"	4	Fastex fastening kit	1
Threaded rod, 1/4-24 x 24"	1	Video cassette	1
Nuts, 1/4-24	4	Panduit terminals, box	1
Nuts, 6-32	8	Panduit ties, bag	1
Socket head cap screws, 6-32 x 1/2"	8	Panduit marker book	1
Cotter pins	4	'Whole kernel corn, bag	1
Washers	10	Mounting plates (on motors)	1
Allen wrench	1	Boston Gear parts:	
Wood Dowel, 1/4" x 24"	2	Plastic bushings, ø3/16", NF35-2-1/2	2
Wood strapping, 1" x 2" x 18"	2	Brass bushings, ø3/16", B35-2	8
Wood strapping, 1" x 4" x 18"	1	Collars, ø3/16", SSC18	4
Particle board, 1/2" x 12" x 18"	1	Shaft coupling, ø3/16", FA5 3/18-3/16	1 set
Plywood, 1/4" x 12" x 12"	1	Sprocket, ø1/4", øø0.731", 9; 25B9	1
PVC tubing, ø3/16" x 48"	2	Sprocket, ø1/4", øø1.598", 20; 25B20A	1
PVC pipe, ø3/4" x 18"	1	Matching chain	1'
PVC pipe, ø1" x 18"	1	Worm gear, ø3/16", øø0.625", 32dp; G1026	1
PVC pipe, ø2" x 22 3/8"	1	Worm, ø3/16", øø0.438", 32dp; LTHB	1
PVC coupling, ø2"	1	Bore reducer inside worm, 3/16" to 4 mm	1
PVC sheet 6" x 72"	1	Worm & reducer already mounted on motor	
High density PE, 1" x 8" x 12"	1	Miter gear, ø3/16", øø0.500", 30dp; L93Y	2
Teflon, 1" x 1" x 1 1/2"	1	Spur gear, ø3/16", øø0.500", 32dp; Y3216	1
ABS sheet, 12" x 12"	1	Spur gear, ø3/16", øø0.875", 32dp; Y3228	1
Lexan sheet, 12" x 12"	1		
Tan plastic structures	2	Digital printer (do not throw away)	1
Coil plastic tube, ø1/4" x 36"	1	Flex shaft for Delco motors	4
Rubber straps	2	T-shirts (for wearing only)	
Rubber bands, small	5		
Rubber bands, large	5		
Rubber strip, 6" x 36"	1		
Hinges with clasps	2		
Wire frame structure	1		
Stainless steel bracket	1		
Semicircular black fiber sheet	1		
Compression spring	1		
Tension spring	1		
Constant force spring	1		
		<b>Non-consumable</b>	
		Delco motors	2
		Portescap motor, 28P11	1
		Portescap motor, 28P11 w/ gearworm	1
		Portescap motors, M1616M11	1
		Aim 10 amp power supply	1
		Controllers w/ umbilical	1
		<b>RUBBERMAID CONTAINER</b>	1

..... has received all components checked off above.  
Team name

.....  
Signature

.....  
Date

## DETAILS

### SAFETY

Due to the nature of the event, in which electrical equipment and tools are used, safety may not and will not be compromised.

1. Safety first.
2. Any machine which appears to be a safety hazard will be disqualified by the referees.
3. For safety reasons, rubber bands may not be used as an energy accumulator.
4. Power supplies may not be tampered with.
5. If a projectile is used, it must have a frontal area greater than 10 square inches.
6. All team members must wear safety glasses (provided at the event) during their matches.

### MACHINE

7. Machines must be designed to operate by reacting only against the top surface of the playing field, the inside face of the rim, the posts (including flanges), the corn, the tennis balls, the opponent, and the air.
8. Machines must display their company and/or school names or logos.
9. During the contest the machine may be interacted with only through normal operation of the control system.
10. Gaining traction by use of adhesives, or by abrading or breaking the surface of the field is not allowed.
11. The machine must remain within the maximum size limit, unconstrained, until power is applied at the beginning of the competition. Once the match begins, the machine may unfold and change size through its own power.
12. All machines will be inspected for compliance with the regulations before the contest. The winning machine will be inspected again following the tournament.
13. If the 9-volt battery is used, it must be connected in such a way, that the position of the balls will not be affected immediately following the end of a match.
14. No substitute machines will be permitted.
15. Following the contest, the machines become the property of U.S. FIRST.  
Arrangements can be made for release of the machines for display and educational purposes.

### FIELD

16. Damaging the field, the controls or the umbilicals may result in disqualification, ie. using spiked wheels is considered damaging to the field and is illegal.
17. A machine may not intentionally contaminate the playing field or an opponents machine with lubricant.
18. At the start of the competition, the machine may be placed anywhere inside the home base, without touching the rim.
19. To receive credit for a tennis ball, the center of the ball must be inside the home base area defined by the vertical planes marking the edges of the painted square regardless of whether or not the ball is inside of the competing device. Referees' determinations will be final.
20. Playing field will be 2 1/2 feet off the floor.

### CONTROLLERS & UMBILICALS

21. The controls and the umbilical supplied in the kit are for practice purpose only. Power supplies and controllers may not be tampered with or adjusted in any way. None of the parts or wire from the controllers or umbilical may be used as part of the machine.
22. Machines must be connected to the umbilical only by normal use of the connectors provided. After only unplugging the connector, a referee should be able to lift the umbilical free.
23. Deliberately using the umbilicals for anything other than transmitting electrical power is not allowed.
24. The connector, with a short piece of wire attached to it, is part of the machine and is subject to all the constraints including the size and weight constraints.
25. The overhead umbilical cable may not be split. If you are making a powered tandem device, you may split the short wire attached to your connector, but you may not tamper with the connector itself, ie removing pins, etc. The tether connecting the two vehicles may not be attached to any overhead support; it is part of your machine and thus subject to the same constraints.

### KIT

26. Kit materials may not be changed chemically. Exception: leads of twine may be singed to prevent unwinding.
27. Some of the kit materials, such as motors , are marked as 'Non-consumable', and must be returned to U.S. FIRST following the contest. These must be used 'as is' and may not be tampered with or changed in any way.
28. Except for wire, no electrical components from the printer may be connected to the controllers. Do not throw away any components disassembled from the printer. They must be returned to U.S. FIRST.
29. Limited numbers of replacement parts are available from U.S. FIRST upon a justified request. Otherwise, lost or damaged kit material may be replaced only with identical components which includes same material, dimensions and treatment.

### TOURNAMENT

30. Each contest will start when power to the control system is turned on and will end 2 minutes later, when the power is turned off, unless on rare occasions whistled dead by the referees.
31. During the tournament, after a team is called to the field a maximum set-up time of 45 seconds will be allowed. Teams will be given at least 1 minute's warning of their table assignments.
32. A maximum of 30 seconds will be allowed for removal of all parts of each machine from the playing field, including any detachable segments.
33. Only two students and two coaches/engineers are allowed in the pit area. All four must be wearing the supplied team shirts. Hats displaying company name or logo should become part of the uniform.
34. During the contest, only the two students may operate the controls. The engineers may assist during set up and removal of the machine. However, during the match they may coach the students only from inside the coaching box marked on the floor.

35. Strategies aimed only at destruction of or damage to an opponent's machine are not in the spirit of the contest and will not be allowed. Turning over an opponent's machine is not considered damaging; but stabbing, cutting, etc. is forbidden.
36. A machine may not win a match through advantage gained by breaking a rule even if done accidentally. Referees may decide to rerun a particular match in such a case.
37. Each team will be provided with a table as a pit area. Each team may bring a hand-held toolbox with basic hand/power tools. If a part requiring machining is broken during competition, DEKA engineers will be available to machine an identical part for you if time, resources and materials permit. You must submit the broken part itself and a machine drawing of the replacement part by 12 midnight on Thursday.
38. Practice time will be available and monitored on Thursday morning in 15 minute slots. A queue will be formed.

#### FIELD

The dimensions and the layout of the playing field are on following page. The surface consists of untreated plywood covered by a layer of whole kernel corn ranging between 1 and 2 inches in thickness. The perimeter of the field is defined by a Plexiglass rim. The home bases are painted on the surface of the plywood with reference marks on the rim. Each of the posts is a filled 2 inch diameter PVC pipe mounted in a cast iron flange bolted to the playing surface. The flange is 3/8 in thick and has a diameter of 5.5 in. The hub projects 5/8 of an inch and the bore has a 2-12 pipe thread. Except for the flange, all material is non-metallic and non-magnetic. An overhead structure supporting the umbilical connections will be held in place by four, 25 ft tall support posts. They are not part of the playing field, although must be taken into consideration in the design of any machine which reaches outside the vertical plane defined by the rim.

A single layer of 150 green tennis balls, each worth one point, will uniformly surround the center post. Three orange balls, one on top of a 12 inch post in the center and two on top of 36 inch posts, are worth 25 points each. The two-tone tennis balls on the remaining two 24 inch posts are worth 10 points each.